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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------------------------|-------------|----------------------|---------------------|------------------|
| 10/766,865 | 01/30/2004 | Shigenori Ishihara | 03599.000092. | 3910 |
| 5514 | 7590 | 10/03/2005 | EXAMINER | |
| FITZPATRICK CELLA HARPER & SCINTO | | | SMOOT, STEPHEN W | |
| 30 ROCKEFELLER PLAZA | | | ART UNIT | |
| NEW YORK, NY 10112 | | | PAPER NUMBER | |
| | | | 2813 | |

DATE MAILED: 10/03/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/766,865

Applicant(s)

ISHIHARA, SHIGENORI

Examiner

Stephen W. Smoot

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 30 January 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-11 is/are pending in the application.
- 4a) Of the above claim(s) 11 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-10 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 30 January 2004 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 3-10-04.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

This Office action is in response to application papers filed on 30 January 2004.

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
 - I. Claims 1-10 are drawn to a hydrogen plasma processing method, classified in class 438, subclass 475.
 - II. Claim 11 is drawn to a hydrogen plasma processing apparatus, classified in class 118, subclass 723.
2. The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the process as claimed can be practiced by another materially

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different apparatus, such as an apparatus that does not utilize the applicant's as-claimed alarm for determining abnormal discharge (see claim 11, lines 18-20).

3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Jason M. Okun on 21 September 2005 a provisional election was made with traverse to prosecute the invention of Group I, claims 1-10. Affirmation of this election must be made by applicant in replying to this Office action. Claim 11 is withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Drawings

5. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference signs mentioned in the description:

100 in Fig. 1 (see page 6, line 11); and

106 in Fig. 1 (see page 6, line 17).

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate

prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

6. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference characters not mentioned in the description:

101 in Fig. 6A; and
103 in Fig. 6A.

Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the specification to add the reference character(s) in the description in compliance with 37 CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

7. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "102" has been used to designate both a microwave oscillator in Fig. 1 (see page 6, lines 15-16) and a substrate in Fig. 6A (see page 8, lines 18-19 and page 15, lines 15-18).

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

8. The drawings are objected to because in Fig. 5, "(RELATIVE VALUVE)" should be changed to --(RELATIVE VALUE)-- to correct spelling.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure

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is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Specification

9. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested: Processing Method that Includes a Microwave Plasma Treatment for Terminating Dangling Bonds in a Silicon-Containing Material with Hydrogen-Containing Plasma.

10. The disclosure is objected to because of the following informalities:

On page 9, line 7, change "130C" to --130D-- because the V-shaped slots 132D in Fig. 4D correspond to slot antenna 130D;

On page 15, line 6, change "lots" to --slots-- to correct spelling; and

On page 19, line 13, change "tem-minute" to --ten-minute-- to correct spelling.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

11. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

12. Claim 10 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 10 recites the limitation "the time of plasma ignition" in line 3. There is insufficient antecedent basis for this limitation in claim 10.

Claim Rejections - 35 USC § 103

13. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

14. Claims 1-7, 9-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sugawara et al. (WO 03/056622 A1 using US 2005/017543 A1 as an English equivalent translation) in view of Phillips et al. (US 6,569,529 B1).

Referring to Fig. 2 and paragraphs [0016] to [0020] and [0052] to [0059], Sugawara et al. disclose a plasma method that includes the following features:

- A substrate (W) that can be silicon is placed on a supporting table (12) (i.e. a susceptor) in a process chamber (11) (also see paragraph [0033]);
- Microwaves are introduced to the process chamber (11) through a window that includes an alumina cover plate (13) (i.e. a dielectric) and a shower plate (14);
- Microwaves are transmitted into the process chamber (11) through the cover plate (13) using an antenna (15) that can be a radial slot antenna;
- The microwaves have a frequency of 2.45Ghz and are emitted to the antenna at a power of 2000watts
- Hydrogen and an inert gas (e.g. argon) are supplied to the shower plate (14) to generate a plasma with an electron density of 10^{11} cm^{-3} using the transmitted microwaves;
- In a first embodiment, the substrate temperature is 250 degrees C; and
- The processing pressure can be varied from 13.3 Pa to 267 Pa to control the plasma intensity.

These are limitations as set forth in claims 1, 3, 5-7, 9-10 of the applicant's invention.

Regarding claim 2, Sugawara et al. are silent regarding the application of a bias to the substrate, which implies that a bias is not required.

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However, Sugawara et al. do not expressly teach or suggest maintaining a distance of 20 mm to 200 mm between the window and the substrate, which is a limitation of claim 1. More specifically, Sugawara et al. do not expressly teach or suggest that this distance is between 50 mm and 150 mm, which is the further limitation to claim 1 as set forth in claim 4 of the applicant's invention. Further, Sugawara et al. do not expressly teach or suggest igniting the plasma at a higher pressure than the processing pressure, which is a limitation of claim 7.

Phillips et al. teach microwave processing using a distance of 4 inches (i.e. about 100 mm) between the window and the substrate (see column 22, lines 54-67).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to arrive at a separation distance that ranges between 50 mm and 150 mm through routine experimentation, in view of the above prior art example of Phillips et al., since it has been held that the discovery of optimum values of result effective variables in known processes are ordinarily within the skill level of the art unless the applicant can show unexpected results for their as-claimed range [see *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)].

Regarding claim 7, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to lower the pressure after igniting the plasma because Sugawara et al. recognize that changing the pressure is one way to control the amount of generated hydrogen radicals (see paragraph [0053]).

15. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sugawara et al. (WO 03/056622 A1 using US 2005/017543 A1 as an English equivalent translation) and Phillips et al. (US 6,569,529 B1) as applied to claim 1 above, and further in view of Cuomo et al. (US 2002/0086534 A1).

As shown above, the combination of Sugawara et al. and Phillips et al. have all of the limitations as set forth in claim 1 of the applicant's invention. However, this combination lacks the further limitation to claim 1 as set forth in claim 8, which is to use a dielectric window that has a thermal conductivity of 70 W/m·K or greater. Cuomo et al. teach a microwave transparent aluminum nitride window that has a thermal conductivity of 320 W/m·K (see paragraph [0084]).

Therefore it would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the combined teachings of Sugawara et al. and Phillips et al. by substituting an aluminum nitride window, as taught by Cuomo et al., for the alumina cover plate of Sugawara et al. Cuomo et al recognize that using a window with high thermal conductivity has the advantage of improved thermal shock resistance (see paragraph [0084]).

Conclusion

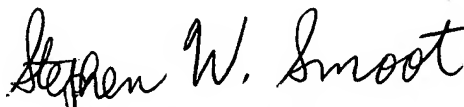
16. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Kanai et al., Fujimura et al., and Chiang et al. teach microwave plasma methods that include utilizing hydrogen gas.

17. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen W. Smoot whose telephone number is 571-272-1698. The examiner can normally be reached on M-F (8:00 am to 4:30 pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

SWS


STEPHEN W. SMOOT
PRIMARY EXAMINER